FUTURE PUBLIC WATER SUPPLIES IN IOWA[1]

By Lafayette Higgins

The following discussion on the future public water supplies of Iowa is intended to be descriptive rather than technical.

Until comparatively recent times, to speak of a public water supply for any inland location was to call to mind the supply obtained from wells. Occasionally such a supply has been furnished by springs. If any such inland territory was developed bringing the land or soil into active cultivation, the natural water supply due to the rainfall and collected mainly in shallow wells, became less and less, until in many instances such sources of supply were abandoned. Following natural inclination, deeper wells came into use and as these failed to supply the need still deeper wells were constructed.

With the better development of cities and towns, the more complete sewering and the more extensive improvement of streets and parks, the constantly increasing use of the public water supplies taxed heavily the resources of the wells, rendering such sources of supply inadequate and unsatisfactory. The lack or the failure of a public water supply by means of wells led to the use of lake and river waters where such were available; and in localities where well supplies are neither available nor suitable and lake and river supplies are impracticable by reason of distance, impounding reservoirs constitute the only remaining available source of supply.

Water is sometimes spoken of as a universal solvent for the reason that most substances readily dissolve in water and very few substances entirely resist solution. This means that any considerable part of rainfall which percolates through soil is continually picking up soluble substances contained in the soil. Therefore any water which sinks to any great depth through earth strata will contain in greater or lesser degree, a considerable mineral content, thereby rendering such water unsuited to some extent for ordinary purposes and sometimes rendering such water totally unfit for either domestic or industrial uses.

[1] Read before the annual meeting of the Iowa Section, April 16, 1919.

The history of deep wells in Iowa may be understood and it is perhaps unnecessary in this discussion to include much of the life history of such wells.

What may be considered deep wells in Iowa, ranging from 200 to 2400 feet in depth, may contain a mineral content ranging from 800 parts to 3000 parts per million. Many of these wells furnish a clear, sparkling water, suitable for drinking purposes, and possibly suitable for other domestic uses at a costly outlay for treatment to partially remove the mineral content usually spoken of as hardness. In the majority of instances, however, the deep well water of Iowa contains mineral compounds rendering the water unfit for ordinary domestic and industrial uses.

It appears to be a working rule among eastern water works engineers that it is ordinarily useless to attempt to render water containing more than about 1100 parts per million of mineral content satisfactory for domestic use by any of the methods of treatment now employed to reduce hardness. Since this discussion is not intended to be technical the reasons for these conclusions may be omitted, with the single statement that it has ordinarily been found that if water contains more than about 1100 parts per million of mineral content, the treatment of the water to remove hardness in large measure simply transposes the so-called hardening and encrusting constituents into other mineral compounds which, though considered soft or non-encrusting compounds, render the water unfit for both domestic and industrial purposes.

With the history of deep wells now abandoned because of this latter condition, we have little concern. As a general proposition, however, the deep well is a costly and unsatisfactory source of public water supply; costly in installation, costly in maintenance and costly in the treatment necessary to adapt it either to domestic or industrial uses. At the present time the deep wells which may be considered to any considerable degree successful and which seem fairly satisfactory to the users, may be found in what might be termed the northeastern one-third of the state. In this portion of the state are found several flowing wells, which in times past have been favorably considered, which generally furnish a highly mineralized water which is considered more and more unfit for use as the years go by. Deep wells installed in middle, south and southwest Iowa have either been abandoned or will be abandoned in the near future.

Another portion of the state of Iowa, which might be roughly described as the northwestern one-third, generally makes use of shallow wells, rarely reaching a depth of 400 feet. The mineral content of these wells is sometimes surprisingly heavy when the depth of the well is considered. In a very few instances in this northwest territory deep wells have been located and occasionally these deep wells are flowing wells.

The increasing draft upon the public water supply of a city or town, occasioned by the installation of a sewer system and the increasing use of such sewer system, usually soon renders inadequate the deep well supply which at first had been found sufficient. The exhaustion of any deep well supply may be considered purely a question of time. The geologists may speculate and compute the possible period of time required for the percolation of rainfall to reach the deep lying strata which furnish the supply for the deep wells, but the reasonable conclusion of the problem is that any considerable daily draft upon such a supply, when continued indefinitely, will curtail and possibly exhaust it. Quite a number of our cities have experienced such results, and have realized the futility of attempting to perpetuate a satisfactory supply from such sources.

On the other hand, many of our inland towns and small cities, particularly in the northern and northwestern portion of the state, have been using wells of moderate depth and capacity. Some of these wells from 200 to 400 feet deep will yield 7000 gallons of water per day; others may yield 25,000 to 35,000 gallons per day and occasionally one is found which may be rated at 100,000 gallons per day. It is easy to see that a town of 1000 population using 60 gallons per capita, which should be a minimum rating when sewer systems and other improvements are installed, does not have a very promising chance for an adequate water supply. Conceding that in such localities such wells must be depended upon as a source of public water supply, the only apparent remedy for the failing supply is to install more wells until the sum of the output is sufficient for the necessary supply.

However, in southern and southwestern Iowa, very little water supply may be obtained from shallow wells and as a rule the supply obtained from deep wells has been found inadequate or unsatisfactory. There remains for these portions of the state little opportunity for a satisfactory source of water supply, except to

make use of the water of the streams through proper purification or by making use of impounding reservoirs located in suitable catchment areas.

This brings us to the consideration of what appears to the author as the probable future practice throughout the state of Iowa.

First. In the inland portions of the state where lakes and streams are not available and where impounding is practically impossible, the municipalities must still make use of drilled wells or tubular wells, multiplying the number of wells to obtain an adequate supply and treating the water of such wells where possible to remove excessive hardness or excessive iron content.

Second. In any locality where an unfailing, natural stream of water of any considerable flow exists, the future public water supply of municipalities located in reach of such a stream may be satisfactorily solved by making use of its water. It may be that the valley of such stream contains gravel beds sufficiently free from silt to permit the collection of the water supply by driven wells, tubular wells, dug wells, or by the gallery system. It is a discouraging fact, however, that very few of the gravel beds lying in our river valleys or adjacent to the streams are suited to the collection of water by means of driven wells. A somewhat larger number will afford the supply by means of tubular wells. However, not many of such locations permit extensive collection of water by means of dug wells and there is only an occasional location where the gallery system can prove permanently effective.

Instances of the failure of driven wells are numerous, although a number of our municipalities are still depending upon this method of collection, preferring to keep up a continual cleaning and replacement of wells rather than to resort to more modern methods. Instances of apparently successful collection by means of shallow tubular wells are not infrequent. Perhaps the largest inland supply furnished by such means of collection is at Newton, Iowa, where tubular wells from 6 inches to 8 inches in diameter and about 50 feet in depth, located in the valley of the Skunk River, about 6 miles from the city of Newton, furnish an apparently inexhaustible supply of excellent water. In this particular instance it would appear to be only a question of multiplying the number of wells and increasing the supply main leading to the city in order to furnish an unlimited supply for the use of the city of Newton, no matter how large the city may become in the future.

The city of Des Moines appears to furnish the one notable instance of successful gallery collection in this middle west country.[2] It is understood that only a few public water supplies of the United States can be as successfully operated by the gallery system.

However, where it is possible to collect a water suppy economically from a river valley by these methods, the supply should be so collected and the water given whatever treatment may be necessary to make it safe and suitable for domestic use. Such treatment may consist of nothing more than chlorination to eliminate pathogenic germs; but it may include, and must necessarily in some locations include, the removal of the iron content which is almost always present in such waters, and it may also require some treatment to reduce the hardness.

Where it is not possible to collect economically the public water supply of a river valley by means of the foregoing methods, the final chance is the use of the water of the river itself. It is, of course, understood in such a case that modern methods of purification and filtration will be employed, but the efficiency of such methods is long past the experimental stage and is now recognized as an accomplished fact.

Recent instances of the necessity for such use of stream water are the city of Clarinda, which in times past has depended upon shallow tubular wells and now contemplates taking the stream water and purifying the same by means of a mechanical filter plant, and the city of Fort Dodge, which is now contemplating a supply taken directly from the Des Moines River and likewise purifying it by means of a mechanical filter plant.

The future record of the public water supplies in Iowa will include many such instances of abandonment of the present methods of collection of public water supply and the institution of direct river supplies. It is likewise true that municipalities which have not yet installed an adequate public water supply will prefer to attempt a river supply rather than to engage in the costly and unsatisfactory experimentation of a tubular well supply.

Third. In any locality where neither shallow nor deep wells are successful and where an adequate river or lake supply is wanting, apparently the only source of public water supply will be the catchment area and the impounding reservoir. This proposition demands

[2] See JOURNAL, September, 1919, p. 475.

at once a consideration of the rainfall and the run-off, the topography, the character of the soil and the surface pollution.

It is common to place the annual precipitation in the state of Iowa at approximately 30 inches. A closer examination of data reveals that the annual precipitation in the northwestern corner of the state is 25 inches, and in the southeastern corner between 35 and 40 inches.

Lines of equal precipitation plotted upon the map would show the 25-inch line running through the center of Lyon County near Rock Rapids and extending in a northeasterly and southwesterly direction. The 30-inch line enters the state at Council Bluffs in Pottawattamie County, runs northeasterly to Rockwell City, thence to Fort Dodge, thence to Waverly, thence in a more northeasterly direction to Decorah and crosses the state line within, and near the northwestern corner of, Allamakee County. The 35-inch line enters the state in Ringgold County, thence runs northeasterly to Leon, Eldon, Fairfield, Washington, Tipton, and crosses the state line and the Mississippi River at Dubuque, thence running almost due east in the state of Illinois. The 40-inch line is entirely south and east of the boundaries of the state. The foregoing review of the annual precipitation will indicate that those localities of the state where impounding must be employed are, generally speaking, the portions of the state where the heaviest rainfall occurs.

A study of the topography of the state and the rainfall determines that in certain portions of the state perhaps 75 per cent of the rainfall enters the soil and 25 per cent becomes run-off, while in other portions of the state perhaps not more than 25 per cent of the rainfall enters the soil and 75 per cent of the rainfall is run-off.

Ordinarily in localities where impounding must be employed, the run-off is more than 50 per cent of the rainfall. Barring dry periods and years of scant precipitation, the topography of the state and the character of the soil in these localities are favorable for the use of catchment areas and impounding reservoirs.

Instances of the successful collection of public water supplies by such method are Centerville and Chariton, both of which cities exhausted all possibility of obtaining public water supplies by means of deep wells and have now succeeded in obtaining satisfactory supplies by the method of impounding and treating the water. A number of other municipalities in southern Iowa have adopted this plan more or less successfully, and it is evident that in southern

Iowa the future public water supplies will be largely impounded where streams are not available.

It is not the purpose of this discussion to enter into a technical explanation of the collection of impounded supplies, the care of impounding reservoirs or the treatment of the water. While it is necessary to exercise all possible sanitary precautions in the selection and care of catchment areas, and it is necessary to protect the impounding reservoir, and sometimes necessary to treat the water of the reservoir to abate algae and plankton, and also necessary to give the impounded water proper treatment to clarify and disinfect it, all of these precautions may be employed and all necessary treatment may be supplied under the knowledge now at hand and by methods now employed.

It is understood that primarily the rainfall furnishes our water supplies no matter what the method of collection. It is true, however, that our attention is directed to the question of rainfall more anxiously in the case of impounded supplies because such supplies are almost wholly made up of run-off water.

A few mistakes have been made locally in estimating the required area of watershed. In certain localities it may not be wise to consider that more than 6 inches of the annual rainfall may be available after allowing for rapid run-off, evaporation and percolation. In other localities the effective amount may be 8 inches or more. By computation of the volume of supply based upon utilized rainfall, the necessary area of watershed may be determined. An effective recovery of 6 inches of rainfall per square mile would provide for a daily supply of approximately 300,000 gallons.

We may therefore summarize the probable future practice in locating and installing future public water supplies as follows:

1. Supplies from rivers and lakes.
2. Supplies from catchment areas and impounding reservoirs where streams and lakes are not available.
3. Supplies from wells in localities where streams and lakes and catchment areas are not available.

Finally the tremendous part which water plays in the natural world and in the sustenance of human life, demands such water supply at whatever cost. It is also true that water supplied at any cost is still the cheapest of the necessities of life. It would appear to be possible to collect and purify the stream and lake water and the impounded water of the state at a cost not exceeding $25.00 per

million gallons, except during flood times or times when silt and surface pollution are maximum. This would mean a cost of $2\frac{1}{2}$ cents per 1000 gallons; and under abnormal prices we might estimate the cost of the collection and purification at 5 cents per 1000 gallons. It would appear, therefore, that the actual cost of collection and purification is one of the minor costs of a safe, sanitary and satisfactory public water supply.